tion of questions as to their size and position; (iv.) effect of rudder action; (v.) effect of gusts of wind; (vi.) investigations as to stability of models for different dispositions of weight, &c.

(12) Materials for aëroplane construction.

(13) Consideration of different forms of aëroplane, monoplane, biplane, &c.

(14) Other forms of heavier-than-air machines, helicopters, &c.

III.—*Propeller Experiments.*

(15) Efficiency and the effect on the efficiency of variations in blade area, pitch, and slip.

(16) Positions relative to the machine.

IV.—*Motors.*

(17) Efficiency.

(18) Trustworthiness and steadiness.

(19) Materials of construction.

(20) Design.

V.—*Questions Especially Relating to Airships.*

(21) Materials of construction, strength, &c.:—(i.) alloys, wood, bamboo, &c.; (ii.) balloon fabrics; (iii.) wires, cords.

(22) Production of hydrogen.

(23) Gas-tightness of fabrics.

(24) Detection of leakage.

(25) Air resistance to ships of different form; experiments on models:—(i.) effect of shape of ends; (ii.) effect of length; (iii.) variation with speed; (iv.) distribution of pressure as affecting stability, strength in construction, position of propellers, fins, &c.; (v.) total resistance of models rigged to represent different balloons.

(26) Questions as to stability of airships in different positions.

(27) Stabilising and steering appliances, fins, rudders, &c.; form and position.

(28) General design.

(29) Navigation of airships. Mooring, &c.

(30) Efficiency and position of propellers for airships.

(31) Motors for airship work.

VI.—*Meteorology.*

(32) General information relating to variations of wind velocity and phenomena connected with gusts of wind.

(33) Relative variation in speed and direction of the wind at different heights above the earth's surface.

(34) Vertical movements in the air.

(35) Rotary movements in the air.

(36) Electrical phenomena.

(37) Formation of clouds, snow, hail, &c.

Eventually the committee decided that the following researches should be undertaken at once:—

(*a*) Experiments on air resistance and on air friction as outlined in (1) to (7) above, and including experiments on models of airships and aëroplanes, resistances of wires and connecting stays, &c.

(*b*) Motor tests.

(*c*) Propeller experiments.

(*d*) Tests for gas-tightness of materials suitable for dirigibles.

(*e*) Experiments on the behaviour of different materials with reference to the accumulation of electrostatic charge, and generally as to means of protecting airships from the effect of electrical discharges.

The interim report points out that additions to the existing buildings at the National Physical Laboratory have been found necessary to provide space for part of the experimental work, while a special building is also being provided for the whirling table referred to below. The equipment which is now being installed comprises the following:—

(i.) A wind channel 4 feet square and about 20 feet long, with a fan giving a draught of 40 feet per second, special arrangements being made to obtain a uniform flow. This will be employed for the determination of the air-pressure components on plane and curved surfaces, for the resistance of models of airships and aëroplanes, and for observations on the centre of pressure, frictional resistance, stability, &c.

(ii.) A whirling table of about 70 feet diameter. For this a special building is being erected; the table itself is under construction in the laboratory. It will be employed for a repetition of Dines's and Langley's experiments, as well as for propeller tests, which are urgently called for.

(iii.) Two wind towers for experiments in the open. These will enable some of the air-channel experiments to be repeated on a larger scale in the natural wind, and will, it is hoped, afford valuable information as to the varying conditions which obtain in practice.

(iv.) Apparatus for efficiency tests on high-speed motors up to 50 horse-power.

In addition, certain machine tools, &c., are being provided for workshop use.

The evidences provided by the interim report of the activity of the committee are gratifying in view of the activity being displayed in other countries in practical aviation. We notice that, on August 7, M. Sommer added another triumph to France in this province of aëronautics. M. Sommer beat the world's record for length of time in the air by flying at Châlons for 2h. 27m. 15s. The record was previously that of Mr. Wilbur Wright, who, on December 31 last, remained in the air at Le Mans for 2h. 20m. 23s.

THE MAGNETIC OBSERVATORIES OF THE U.S. COAST AND GEODETIC SURVEY.[1]

A LIBERAL addition made in 1899 to the funds available for magnetic work by the U.S. Coast and Geodetic Survey enabled a great extension to be made in the direction of magnetic observatories. Previously to that date the only magnetographs run by the Survey were an old Brooke instrument, first set up in 1860 at Key West, and an Adie instrument installed in 1882 at Los Angeles, and subsequently in use elsewhere. These two instruments are still in use, the Brooke in modified form at Vieques, the Adie at Cheltenham (fourteen miles south-east of Washington, D.C.), the central station of the Survey. Cheltenham also possesses a new set of Eschenhagen instruments, and similar instruments were also obtained for Baldwin, Sitka, and Honolulu. The curves from the five observatories are tabulated at a central office, and the volumes containing the earliest years' results have recently appeared. The material is dealt with after a uniform plan. Each volume discusses the buildings and instruments, and enumerates the base-line and scale-value changes. It is interesting to learn that the experience at Cheltenham "is decidedly favourable to the old Adie type, on account of its greater stability and the less frequent adjustments required." Another instrumental point of interest relates to the temperature coefficients of the horizontal force instruments. That of the Adie instrument appears exceptionally large for an instrument of its type, but it is less than half the average value for the four Eschenhagen instruments, and only one of the latter is worse than the Brooke in this respect. When a rise of 1° C. in temperature produces the same effect in the trace as a fall of 17 γ in the force—as seems to be the case at Honolulu—satisfactory elimination of temperature effects must be troublesome. If the cause lies in the quartz-fibre suspension, a substitute should be sought for.

The greater part of each volume is devoted to the hourly readings from the curves. Declination and horizontal intensity results are given for all the stations, but vertical intensity results only for Cheltenham. Mean hourly values are deduced for each month, first from all the days, and, secondly, from the ten least disturbed days. The latter form the basis of the regular diurnal inequalities given for each month. Inequalities are calculated for the northerly and easterly components as well as for declination and horizontal intensity, and at Cheltenham for dip as well as for vertical intensity. Under the heading "Daily Range of Declination" we have tables of values

[1] Results of Observations made at the Coast and Geodetic Survey Magnetic Observatories, Cheltenham, Maryland, 1901–4. pp. 206; Baldwin, Kansas, 1901–4, pp. 138; Sitka, Alaska, 1902–4, pp. 129; near Honolulu, Hawaii, 1902–4, pp. 130; and Vieques, Porto Rico, 1903–5, pp. 70. By Daniel L. Hazard, Computer, Division of Terrestrial Magnetism. (Washington: Government Printing Office, 1909.)

of the maximum and minimum for each day, and their times of occurrence, to the nearest minute; but the actual *range* is not given explicitly. The space allowed to the date is unnecessarily large, and it would probably be found possible to add the daily range without unduly crowding the figures. This would be a welcome addition.

An interesting feature is a list of the disturbed days, classified 1 to 4 according to the intensity. The highest figure, 4, is reserved for one or two exceptional disturbances, being applied at one or two stations only to October 30–31, 1903. Copies are also given, except in the case of Baldwin, of the curves from a considerable number of the disturbed days, the same selection being made for all the stations. This is likely to prove a valuable feature. Its value, however, is somewhat lessened by the fact that the curves are shown on a considerably reduced scale. Comparisons requiring high accuracy in the time must suffer. The fact that local time is employed is also somewhat of an obstacle to inter-comparisons. The disturbed curves are all from Eschenhagen instruments, which record all the elements on one sheet. This brings before the eye all that was happening simultaneously in the several elements. This is a distinct advantage in the study of disturbances, provided the different curves can be kept distinct. Sitka, owing to its higher latitude, is exposed to larger magnetic storms than the other stations, and the clearness of a good many of the curves reproduced suffers from crossing and confusion of the declination and horizontal force traces. October 30–31, 1903, was naturally an outstanding case of this; but on that occasion there was, besides, great loss of trace, the movements being so rapid that no clear record appeared on the photographic paper. The sensitiveness of the horizontal force instrument at Sitka was reduced towards the end of 1904 to about 1 mm.$=3\gamma$, as compared to an average of about 1 mm.$=1{\cdot}8\gamma$ in 1902 and 1903. The sensitiveness that used to be aimed at in temperate Europe is 1 mm.$=5\gamma$, and we cannot but think that the reduction of sensitiveness in Sitka might with advantage go a good deal further than it has yet gone. Though not quite so easily effected, a reduction in the sensitiveness of the declination instrument at Sitka might also be advantageous, at least for a study of the larger features of magnetic storms. The device of two mirrors adopted in the magnetographs to avoid loss of trace is an alleviation if the movements are slow, but if, as is frequently the case, the movements are not merely large but rapid, this device may only aggravate the confusion of trace.

The volumes contain a great mass of facts, clearly printed, presented in a readily intelligible form. Having put their hand to the plough, it is to be hoped that those responsible for the work of the Coast and Geodetic Survey will not turn back until simultaneous records have been obtained for at least one sun-spot cycle at all the stations.

C. CHREE

RECENT ADVANCES IN OUR KNOWLEDGE OF SILICON AND OF ITS RELATIONS TO ORGANISED STRUCTURES.[1]

NOT only is silicon widely diffused in nature in the many forms of its oxide, but it also constitutes between one-third and one-fourth of the original and non-sedimentary rocks—of which the solid crust of the earth largely consists—in these cases being chemically combined with oxygen and various metals, forming natural *silicates.* The subjoined table gives a necessarily very rough estimate of the relative proportions in which the chief constituents are present.

THE EARTH'S CRUST.

Approximate average Composition of non-sedimentary Rocks.

Oxygen	about 47	per cent.
Silicon	,, 28	,,
Aluminium	,, 8	,,
Iron	,, 7	,,
Calcium and magnesium ...	,, 6	,,
Alkali metals	,, 4	,,

[1] From a discourse delivered at the Royal Institution on Friday, May 28, by Prof. J. Emerson Reynolds, F.R.S.

The crust of the earth is, in fact, a vast assemblage of silicon compounds, and the products of their disintegration under the influence of water and other agents are the various forms of clay, sand, and chalk which constitute so large a portion of the earth's surface.

The solid crust of the earth is actually known to us for but a very few miles down—thirty at most—our deepest mines being mere scratchings on its surface; but, so far as known, practically all its constituents are fully oxidised, and this is probably true at much greater depths. During æons past oxygen has been absorbed as the earth cooled down, and the product is the crust on which we live.[1] It is probable that the proportion of oxygen diminishes away from the surface until it disappears almost wholly. What of the deeper depths? Are the comparatively light elements arranged more or less in the order of density? Are we to suppose that silicon and some carbon, aluminium, calcium, the elements chiefly comprising the crust, are those nearer the surface, and iron, copper, and the heavier metals nearer the centre?

Until recently we knew little more than that the earth is some 8000 miles in diameter, that its mean density is 5·6–5·7, and that its relatively thin outer skin, or crust, has approximately the composition already described. By a very skilful use of earthquake observations Mr. R. D. Oldham has, however, lately[2] given us something like a glimpse within the ball, and concludes from his observations that about five-sixths of the earth's radius includes fairly *homogeneous* material, and that the remaining sixth at the centre consists of substances of much higher density. Assuming this to be even roughly true, we conclude that silicon forms probably as great a proportion of this large mass of the earth—whether in the free state or in the forms of silicides—as it does of the crust.

Having thus magnified the office of the important element of which I wish to speak to you, I shall pass to my next point, which is how the element can be separated from quartz or other forms of the oxide, for it is never met with unless combined with oxygen in any of the rocks known to us.

I have already mentioned that quartz is a dioxide of the element—in fact it is the only known oxide—hence if we remove this oxygen we should obtain free silicon. This is not a very difficult matter, as it is only necessary to heat a mixture of finely powdered quartz with just the right proportion of metallic magnesium. The metal combines with the oxygen of the quartz, and forms therewith an oxide of magnesium, while silicon remains. If the material be heated in a glass vessel the moment of actual reduction is marked by a bright glow, which proceeds throughout the mass. When the product is thrown into diluted acid the magnesium oxide is dissolved, and nearly pure silicon is obtained as a soft, dark-brown powder, which is not soluble in the acid. This is not crystalline, but if it be heated in an electric furnace it fuses, and on cooling forms the dark crystalline substance on the table, which, as you see, resembles pretty closely the graphitic form of carbon, though its density is rather greater (2·6, graphite being 2·3).

Silicon Analogues of Carbon Compounds.

The points of physical resemblance between silicon and carbon are of small importance compared with the much deeper-rooted resemblance in chemical habits which exists between the two elements. This is expressed in the periodic table of the elements as in the following diagram:—

$$\begin{array}{lllllll} Na=23, & Mg=24, & Al=27, & \mathbf{Si}=28, & P=31, & S=32, & Cl=35{\cdot}5 \\ Li=\ 7, & Be=\ 9, & B=11, & \mathbf{C}=12, & N=14, & O=16, & F=19 \end{array}$$

where silicon is represented as the middle term of a period of seven elements of increasing atomic weights, just as carbon is the middle term of the previous period. The fact is, these two electro-negative or non-metallic elements play leading parts in the great drama of nature, silicon

[1] An interesting calculation has been made by Mr. Gerald Stoney, from which it appears that a stratum only 9 feet in depth of the surface of the earth contains as much oxygen as the whole of our present atmosphere. (See *Phil. Mag.*, 1809, p. 566.)

[2] R. D. Oldham. "Constitution of the Interior of the Earth." (Quarterly Journal of the Geological Society, vol. lxii., 1906, pp. 456–75.)